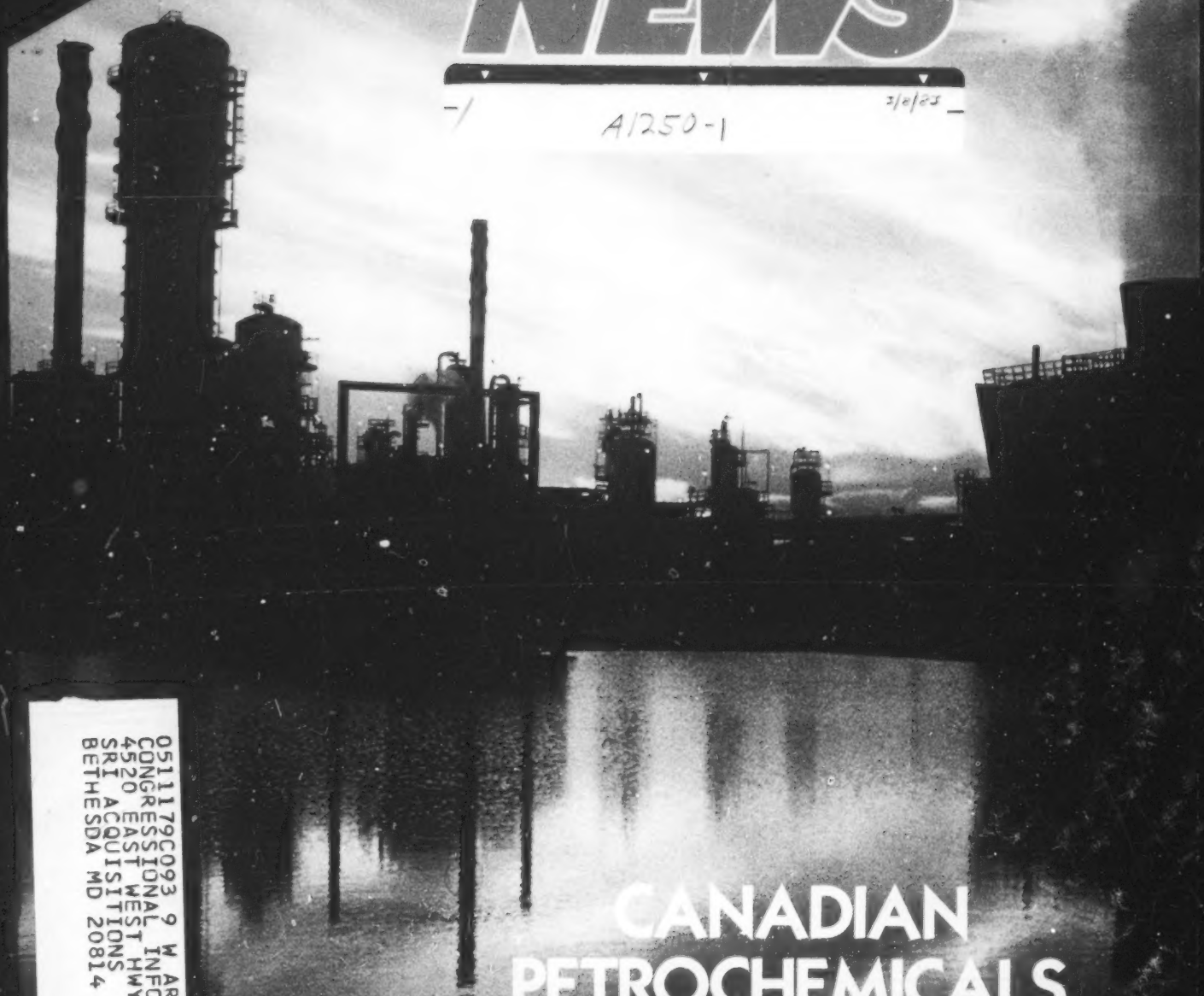
MARCH 7, 1983

CHEMICAL & ENGINEERING

NEWS

Flame retardants—high-tech markets spark growth Page 15

-/ A1250-1 3/8/23



CANADIAN PETROCHEMICALS

The fight for survival Page 7

05111179C093 9 W AR611OSL 1
CONGRESSIONAL INFO SERV
4520 EAST WEST HWY SUITE 800
SRI ACQUISITIONS
BETHESDA MD 20814

BEST AVAILABLE COPY

Cover: Styrene plant at Sarnia, Ont., recently completed by Canadian Badger (part of U.S. Badger) for Polysar

Volume 61, Number 10
CENEAR 61 (10) 1–44
ISSN 0009-2347

CHEMICAL & ENGINEERING
NEWS
MARCH 7, 1983

News of the Week

■ **Chemical employment drops further as PPG makes major cuts in U.S. chemical staff.** **Page 4**

■ **Reagan's proposal on natural gas deregulation, now in Congress, may result in lower prices.** **Page 5**

■ **Leaked "hit list" of technical advisers not acceptable to EPA fuels agency controversy.** **Page 5**

■ **Japan's Osaka Transformer Co. and Allied join forces to develop Metglas transformers.** **Page 5**

■ **Du Pont hopeful that its new toughened grades of polyacetal resin will increase sales.** **Page 6**

■ **Certain fluorinated plant steroids are converted into insecticides by insects themselves.** **Page 6**

Business

Growth in flame-retardant chemicals for major plastics would be aided greatly by stricter federal safety standards. **Page 15**

Government

EPA remains under fire as charges of conflict of interest, lying, and improper conduct are leveled at top officials. **Page 20**

Science

Chemical contents of the American diet are studied in depth by little-known FDA food analysis program. **Page 23**

Efficiency of nonaqueous photocells is improved by Stanford University researchers' use of photoanodes. **Page 25**

Technology

Novel high-gravity technology developed by U.K.'s Imperial Chemical Industries may replace familiar distillation towers. **Page 26**

Science Policy

American Physical Society resolution commits U.S. physicists to advancing control of nuclear weaponry. **Page 27**

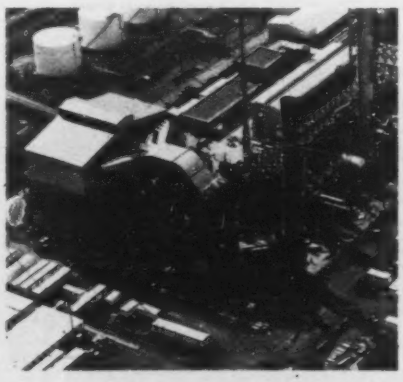
Books

"Last Aid: The Medical Dimensions of Nuclear War" offers graphic evidence that no one wins in a nuclear conflict. **Page 29**

Letters 2

Concentrates
Business 14
Government 19
Science/Technology 22

The Departments
ACS Comment 31
Meetings 33
Newscripts 44



News Focus

After a spate of new plants in the 1970s, Canada's once-promising petrochemical industry now is fighting for survival. **Page 7**

Canadian Petrochemicals: Great Opportunity Has Turned Sour

It's East vs. West and oil vs. natural gas as federal government tries to determine how it can help once promising, but now ailing, petrochemical industry

Earl V. Anderson, C&EN New York

Very soon, Chem Systems, the Tarrytown, N.Y.-based consulting firm, will launch a major multiclient study on the petrochemical industry of Canada. That it should choose the Canadian petrochemical industry as a subject hardly comes as a surprise. Many observers of the world petrochemical scene are wondering in amazement just what has happened to bring Canada's once-promising petrochemical industry to its knees and whether the industry will be able to regain the potential that everyone seemed certain it could attain.

The answer to the first question is complex, but there to decipher. It involves an unfortunate (for Canadian petrochemical producers) national energy pricing policy and even more unfortunate timing that brought a domestic and worldwide recession and falling world energy prices into play with it.

Exports, in vessels such as this Dow Chemical Canada tanker, are important but now weakened outlet for Canadian chemicals

The answer to the second question has not yet surfaced, though it may very soon. But when it does, it will rise out of federal government offices in Ottawa, and perhaps from some provincial capital, more so than out of the industry itself.

The reason is simple enough. It was, in large measure, government policy on energy prices that helped push the Canadian petrochemical industry into trouble. It may take a revamped energy pricing policy to pull it out.

Canada, of course, is a hydrocarbon-rich country, one of the very few among industrialized countries. After years of lying dormant, the country's small, inefficient petrochemical industry sprang to life in the mid- and late seventies. Lured by plentiful and inexpensive natural gas in Alberta, the industry launched a major round of world-scale plant building in the province.

In western Canada, the emphasis was on ethane-based ethylene, its derivatives, and methanol. However, other ambitious projects were put into brick and mortar or planned by the established, oil-based segment of the industry in the eastern petrochemical centers of Sarnia, Ont., and Montreal, Que.

With a population of only 27 million, roughly one

Petrochemical investment in Eastern Canada totals $3 billion

	$ Million (Canadian)		$ Million (Canadian)
Dow Chemical	$150	Polysar	$ 600
Du Pont	350	Shell	300
Esso	200	Union Carbide	350
Hercules	50	Other	250
Petromont	50	TOTAL	$3000
Petrosar	700		

Note: Investment is in Sarnia, Ont., and Montreal, Que., areas. **Source:** Union Carbide Canada

tenth that of the U.S., only one world-scale plant could service the domestic Canadian market for most major petrochemical products. But Canadian petrochemical companies, most of which are subsidiaries of multinational companies with established worldwide marketing networks, have their eyes on export markets.

As recently as two years ago, Canadian companies talked confidently about a "window of opportunity" through which they could leap to world petrochemical prominence. By moving swiftly, they could capture markets made available as hydrocarbon-poor countries such as Japan cut petrochemical capacity and before potential competitors such as Saudi Arabia and Mexico could launch their own assaults on the world marketplace. The scenario, especially in view of Canada's advantage in feedstock pricing, seemed unassailable.

Last year, however, it became painfully apparent just how tenuous that scenario was. Virtually all Canadian companies involved in petrochemicals lost money—a lot of money. A couple of them have edged dangerously close to financial disaster.

Production was off considerably last year. Sales were down. Exports suffered.

Plant operating rates were uncomfortably low. Scheduled plant shutdowns were extended and other plants simply shut down for lack of demand.

Layoffs were commonplace throughout the industry. Many capital spending projects were delayed, canceled, or scaled back.

Reeling from these blows, the industry has turned, as many Canadian companies are prone to do, to the government for relief and aid. More specifically, a group of oil-based petrochemical companies in eastern Canada has mounted a highly visible campaign to obtain government assistance in solving their problems.

This in itself has complicated Canada's petrochemical future. The industry is badly divided on the issue. Western gas-based producers sharply disagree with their eastern cousins about the type of aid that is needed; indeed, whether any aid is needed at all.

In part, these differences reflect traditional provincial jealousies that have long existed in Canada. But only in part. Mostly, they reflect the different strengths and weaknesses that each faction perceives itself to have.

Even in the East, not all petrochemical companies think that government assistance is necessary. The group that is petitioning Ottawa for help is led by Petrosar Ltd. and Petromont Inc. and includes six other companies that are either their owners, their customers, or both. Petrosar operates the petrochemical core complex around which Sarnia's "chemical valley" is built. Petromont fills that same role in the Montreal area.

This dichotomy in the industry's attitude about what is and what is not necessary to get back on its feet, unquestionably is making an already difficult search for a solution even more difficult. That search really started last spring when a government task force was formed to look into the problems of Canada's petrochemical industry.

The task force completed its report last fall. It was, according to one participant, an "analytical job" designed to "give the ministries certain options that they had for action, including no action."

It was a "factual" report and contained no recommendations. It also has been kept highly confidential.

Since then, the government's chemical experts have been conferring with the ministries involved, revising and updating their information and making recommendations. Again, very little has leaked out about these proceedings.

About all that one participant will say is that "the ministers are giving the situation priority consideration. Their decision is imminent."

Indeed, it may be very imminent. Industry leaders have been expecting something to break for weeks now.

Whatever it is that the ministers decide to do—or not do—their decision will play an important role in shaping the future of Canada's petrochemical industry. This isn't really startling; it has been the government's policies, especially those dealing with energy pricing, that have helped shape industry developments over the past several years and have helped to put the industry in its present predicament.

Canada's hydrocarbon resources are the envy of many less-endowed industrial countries. Oil and gas producers, primarily in Alberta, have supplied about 75% of Canada's oil requirements. Some eastern provinces rely on imported crude because pipelines aren't available to carry western Canada crude to them.

In addition, western gas producers supply all of Canada's natural gas requirements, with more than enough left over to export about a third of their production to the U.S. Reserves of natural gas are increasing. These resources, along with a policy that has kept prices down, has created an attractive climate for petrochemical investment.

In 1978, Petrosar came on stream with its petrochemical refinery near Sarnia. It included a crude oil topping unit and a naphtha cracker capable of producing 1 billion lb per year of ethylene, 725 million lb of propylene, and lesser amounts of C-4s and aromatics.

Petrosar is a joint venture owned by Polysar Ltd. (40%), Du Pont Canada (20%), Union Carbide Canada (20%), and Canada Development Corp. (20%). Petrosar supplies raw material that its chemical company owners need to run their nearby derivatives plants.

In 1979, Alberta Gas Ethylene started the petro-

chemical ball rolling in Alberta with its first ethylene plant (AGE I), a 1200 million lb-per-year unit at Red Deer. In two short years, Canada's ethylene capacity leaped from just over 1 billion lb to 3.25 billion lb.

A year later, in Montreal, two area chemical companies formed Petromont in an effort to consolidate their petrochemical base. Gulf Canada and Union Carbide Canada each own one third of Petromont. The other third is owned by the province of Quebec through its holding company, Société Generale de Financement (SGF).

Petromont is the nucleus of the Montreal area petrochemical industry. It has a 55,000-metric-ton ethylene plant in Montreal East and a 225,000-metric-ton unit at Varennes. With an eye toward future petrochemical development in the area, Petromont has sketched plans to double capacity at Varennes.

Hard on the heels of this start, a flood of new plant announcements poured out of Canada. Some projects were slated for the East, but most were earmarked for the West.

Alberta Gas Ethylene launched its second world-scale ethylene project (AGE II) with a capacity of 1.5 billion lb. The company started planning for AGE III, another 1.5 billion lb ethylene unit. Meanwhile, Esso Chemical, Alberta Energy Co., and Hudson's Bay Oil & Gas planned a 1.5 billion lb ethylene plant of their own at Redwater, Alta.

Producers of ethylene derivatives launched their own projects and battled to capture a share of the ethylene that was to come. In addition, benzene, styrene, methanol, ammonia, and urea projects were unfurled in Alberta.

For plants coming on stream in the province between 1981 and 1986, the estimated tab exceeds $5 billion (Canadian dollars throughout the article).

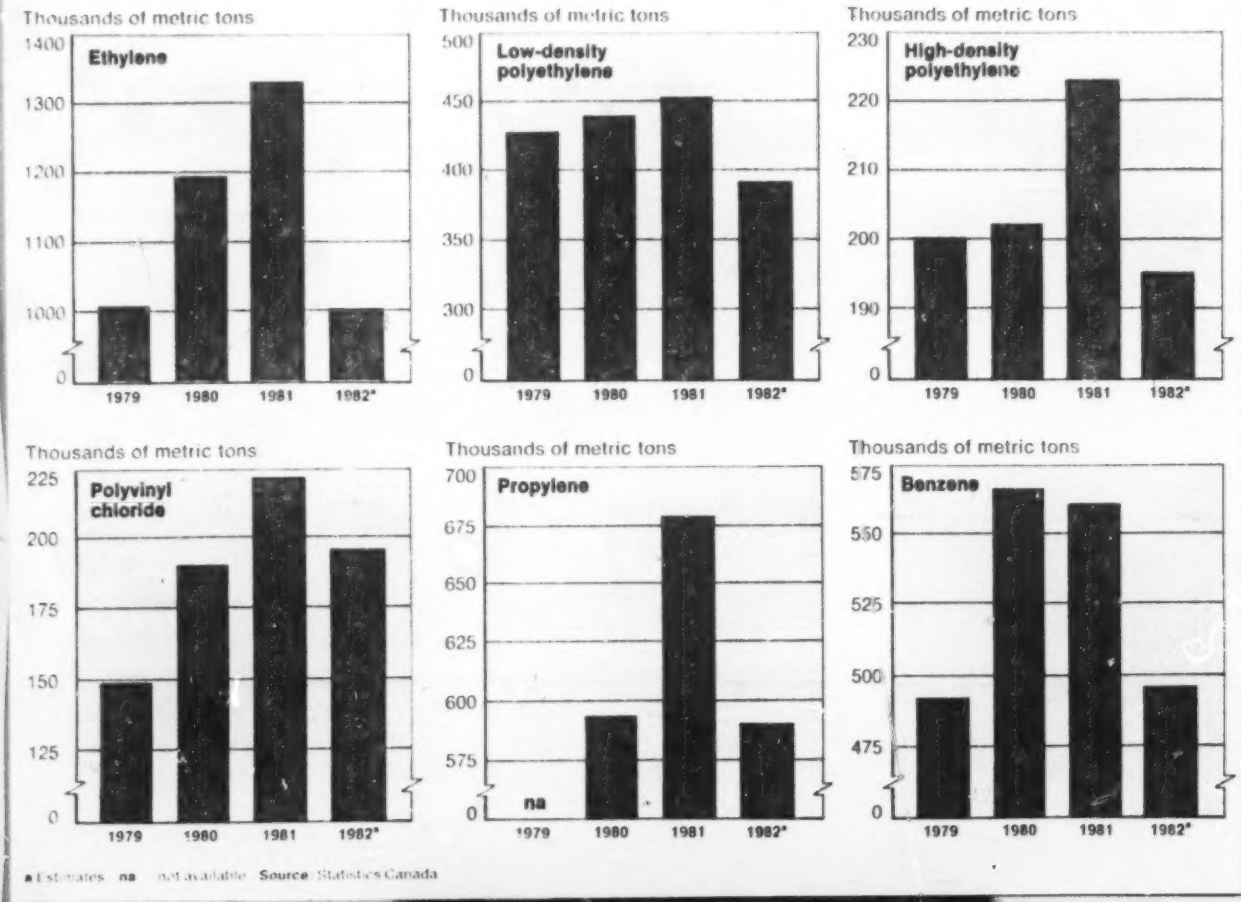
Enthusiastic petrochemical planners, confident that they could turn loose all of their output on the export markets, didn't anticipate what was going to happen in Canadian energy politics.

Agreements that set oil and gas prices in the late 1970s expired in early 1980. Taking their place was Canada's highly controversial National Energy Program (NEP).

NEP was born at a time when Canada was using more oil than it was finding. Natural gas reserves, however, were mounting. The new energy program reflected this by promoting natural gas at the expense of oil.

For petrochemicals specifically, NEP stipulated that

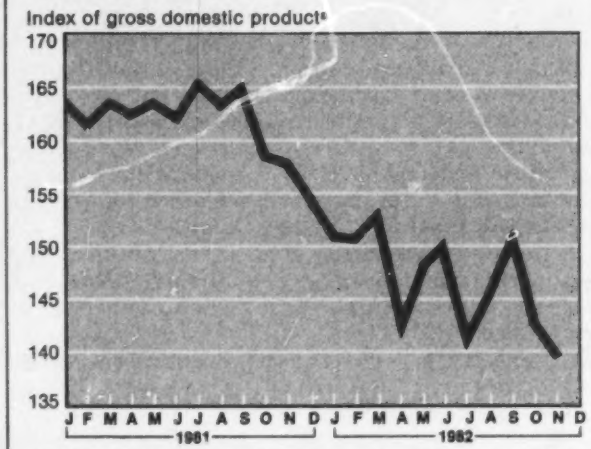
Production of most major petrochemicals dropped in Canada last year



*Estimates na not available Source: Statistics Canada

BEST AVAILABLE COPY

Canadian chemical output has fallen off sharply



a Chemical and chemical product industries, seasonally adjusted, 1971 = 100.
Source: Statistics Canada

no additional volumes of oil were to be used to support future industry growth. This came as a blow to oil-based producers in the East. However, it stated that Canadian prices never would exceed 85% of the world price or the average U.S. price, whichever was lower. Natural gas prices were set at 65% of crude prices.

At the time, it appeared that NEP guaranteed Canadian petrochemical producers a feedstock advantage. That didn't last long. Alberta, dissatisfied with the low prices that it was receiving for a depleting resource, forced a new pricing policy out of Ottawa. It doesn't mention an 85% ceiling.

Policy makers, blindly anticipating ever-rising world oil prices like many others at the time, assumed that the 85% ceiling would not be breached. The new agreement called for a rigid, inflexible schedule of price hikes for Canadian oil.

The Canadian petrochemical industry, says C. L. (Cliff) Mort, former chairman of Dow Chemical Canada and now a consultant, "was asleep at the switch." Mort says that he detected very little dissatisfaction with energy prices.

It wasn't long before dissatisfaction set in. Starting in mid-1981, and even more dramatically last year, Canada's petrochemical fortunes plummeted. André G. Lapalme, vice president and general manager of hydrocarbons for Union Carbide Canada, says, "We now are fighting for survival."

Like other industries, the Canadian petrochemical industry had to contend with recession, both at home and in its major foreign markets. It also had another cross to bear. While feedstock costs throughout the world were tumbling, especially along the U.S. Gulf Coast, they were rising in Canada.

In a recent update of a brief prepared by eastern producers for the government, it is estimated that the blended oil price at Montreal last September was 89.9% of the average U.S. price. This month, it's estimated to rise to 98.3%. Both are well above the 85% ceiling promised by NEP.

Squeezed by sagging markets and rising feedstock costs, Canada's chemical companies took a financial beating last year. Combined sales of four companies charted by C&EN (C-I-L, Celanese Canada, Du Pont Canada, and Union Carbide Canada) fell 12.5%. More important, these companies lost $15.7 million on those sales.

Canadian chemical exports also fell—11.6% to just over $4 billion. Carbide's exports were off by a third and Du Pont's were down 21%, indications of just how much the industry's competitive edge was dulled.

Operating rates, employment, and investment plans were scaled back. Permanent plant shutdowns loomed as a definite possibility.

In Alberta, the AGE II ethylene project is proceeding on schedule, but derivative plants will be able to take only two thirds of its capacity by 1985. Meanwhile, AGE III and the Esso-Alberta Energy ethylene plant have been postponed indefinitely. Observers doubt if the fourth ethylene unit will ever be built.

Canadian ethylene capacity, once forecast to hit 9 billion lb by 1987, now is pegged at only 4.6 billion lb. Present capacity is 3.4 billion lb.

In the East, some companies face the possibility of folding. Petromont and Petrosar are in big financial trouble.

Petromont's expansion ambitions have been scrubbed. Serge Guerin, Petromont's assistant to the president, says that the company could shut down soon if it doesn't get a prompt, $30 million shot in the arm.

In Sarnia, Petrosar president Charles Ambridge concedes that company losses last year were "in the tens of millions of dollars." Petrosar claims that it has no intention of closing down, but outside observers openly wonder how long it can last without government assistance. In 1986, a government-held debenture of $350 million becomes due.

Government help is exactly what Petromont and Petrosar are seeking. Detractors say that they want a handout or bailout. Eastern companies maintain that they are after relief and incentives.

Whatever it's called, Petromont, Petrosar, and six other eastern companies (BASF Canada, Du Pont Canada, Hercules Canada, Polysar, Société Generale de Financement, and Union Carbide Canada) presented Ottawa with a brief last October outlining their problems and possible solutions.

The eight companies insist that long-term prospects for petrochemicals in Montreal and Sarnia are promising. At stake is survival over the short term. They want Ottawa to act, and act fast.

Their problem is twofold: the recession with its weak markets, and high feedstock costs. The recession they can do nothing about, but they believe that something can and should be done about feedstock costs, which account for 60 to 75% of total product costs.

They emphasize that a heavy tax burden on crude oil is a major cause of their high feedstock costs. Of the roughly $35 per barrel for Canadian blended crude, more than $27, or 78%, goes into federal and provincial

Eastern petrochemical producers think their oil is too expensive

Eight petrochemical companies in eastern Canada, whose raw materials depend on crude oil-based feedstocks, have petitioned the government for immediate short-term relief, especially relief from up-front taxes on crude oil and a long-term feedstock policy distinct from energy policy.

These companies—BASF Canada, Du Pont Canada, Hercules Canada, Petromont, Petrosar, Polysar, Société Generale de Financement, and Union Carbide Canada—claim that the heavy dose of up-front taxes and a rigid schedule of price increases have eroded the price advantage that they thought they had received under Canada's National Energy Program (NEP) of 1980. NEP states that "the blended price of oil (old, new, and synthetic oil) will never exceed 85% of the international price or the average price of oil in the United States, whichever is lower."

NEP authors, however, never reckoned with falling world crude prices. Now, eastern petrochemical producers claim that, as a result of falling world prices and increasing Canadian prices, they have lost their all-important feedstock advantage.

Here's how these producers figure what it's costing them for their crude. Taxes, both federal and provincial, account for about 78% of the total.

	Actual Sept. 1982	Estimated March 1983
	($ per bbl, Canadian)	
Producer	$ 5.95	$ 6.87
Alberta royalty	9.76	11.28
Petroleum and gas revenue tax	2.53	2.92
Federal income tax	6.16	7.12
Alberta income tax	1.35	1.56
Incremental oil revenue tax	0	0
Wellhead price of old oil	$25.75	$29.75
Petroleum compensation charge	6.30	3.76
Canadian ownership special charge	1.15	1.15
Transportation (to Montreal)	1.67	1.74
BLENDED PRICE AT MONTREAL	$34.87	$36.40

As a result of the fixed-schedule price increases and the heavy tax burden, eastern petrochemical companies claim that their oil costs already exceed the 85% limit promised by NEP.

The calculations below were made before the most recent round of price cuts in world oil. With them, eastern petrochemical producers may end up paying more for their oil than the prices on either the world or U.S. markets.

	Actual Sept. 1982	Estimated March 1983
	($ per bbl, Canadian)	
Blended price at Montreal	$34.87	$36.40
International price (landed at Montreal)	40.94	39.71
International price (quality adjusted)	41.75	40.52
Average U.S. price	38.78	37.04
Blended price ratio		
vs. actual international	85.2%	91.7%
vs. quality-adjusted international	83.5%	89.8%
vs. U.S. price	89.9%	98.3%

Source: Report, "Problems of the Petrochemical Industry in Ontario and Quebec. Update" (Feb. 4, 1983)

coffers. Producers receive only $5.95. If world prices for oil continue to go down, the competitive position of eastern chemical companies will deteriorate even further.

What the eight companies recommend is a three-part fix:

- A short-term relief mechanism.
- A petrochemical feedstock policy for the long term that distinguishes between feedstock and other uses of oil and gas.
- Enough flexibility and pricing controls in that feedstock policy to enable the eastern oil-based industry to remain competitive with its western, gas-based counterpart.

Specifically, the companies want an immediate exemption from the petroleum compensation charge and the Canadian ownership special charge for all oil that is upgraded into petrochemicals. This would cost the government about $125 million per year.

As part of long-term feedstock policy, they suggest placing a cap on feedstock prices just as NEP intended to do with oil. However, they want enough flexibility in setting that cap to contend with changing world competitive conditions.

Eastern producers believe that they can adapt their plants to use a more varied mix of feedstock, including the liquefied petroleum gases propane and butane. Indeed, they want to, but only if LPGs are priced competitively with natural gas.

That's because eastern producers are looking in two directions at the same time. They want to be internationally competitive, but they also want competitive equality with western gas-based producers. Indexing natural gas at 65% of crude, they argue, was done for energy reasons, not to promote a petrochemcal industry in Alberta at the expense of the East.

By competitive LPG prices, of course, the eight companies mean lower prices. Export prices, relatively high and profitable for LPG producers, set the price in Canada. In effect, they establish a floor under domestic prices that eastern companies consider too high.

In addition, the Natural Gas & Gas Liquids Tax (NGGLT), which is levied on propane and butane but, significantly, not on ethane, lifts the LPG floor even higher. As a result, eastern producers say that LPG prices are too high for them to consider.

What they would like to see is the LPG price floor lowered by a combination of export restrictions that would drive the price down in Canada, and NGGLT eliminated to drive it down even more.

Add to that some federal aid in the investments needed to build delivery and storage facilities, and

eastern petrochemical producers would be willing to modify their plants to handle LPG.

The eight companies have backed up their proposals with some powerful arguments. They emphasize, for instance, the importance of coproducts available from naphtha cracking that aren't available from ethane-based ethylene plants. Propylene and C-4s are important to eastern downstream companies, especially C-4s for Polysar's rubber operations.

They argue that, even if someone wanted to develop an oil-based industry in Alberta where the oil is, high distribution costs to eastern markets would make it an unprofitable proposition. And, says the eastern contingent, even if they convert partially to LPG, they still would be able to meet eastern coproduct requirements.

Other arguments are certain to set politicians to thinking. The eight companies have developed figures that indicate, without relief, about 54,000 jobs would be in jeopardy, either in the industry directly, or in downstream and consumer industries. With unemployment high in Canada, that's hard for politicians to ignore.

If the eastern industry gets its relief, the government would receive an additional $385 million in personal and corporate income taxes and savings in unemployment payments. Without relief, it would lose $800 million.

Canada's balance of trade also would suffer. Given relief, eastern chemical companies could help boost the trade balance $1.5 billion. Without it, the trade balance would drop a hefty $3 billion because of lost export opportunities and increased imports.

Unlike the eastern companies, which have gone public in a big way with their side of the story, western companies have been noticeably silent. That soon may change.

"Eastern companies weren't the only ones hurt last year," says John E. Feick, senior vice president for Novacor Chemicals. At one point, ethane prices were 25% higher in Alberta than they were on the Gulf Coast. The operating rate for AGE I averaged only 55% in 1982. The gas-based industry in western Canada lost about $70 million last year, according to Feick. Despite this, western producers are reluctant to complain or to ask the government for assistance.

The western industry is confident that, over the long haul, it can regain its competitive edge over U.S. producers, who are its primary competition.

Dow Chemical Canada, which has a foot in both camps, thinks that the present situation is a short-term phenomenon for western companies. Says board chairman James M. Hay, "We should let the market resolve our problem."

Western producers particularly resent any assistance that might be supplied specifically to Petromont and Petrosar. "That," says Feick, "will alter the natural competitive battle between liquids in the East and gas in the West."

The West, including gas companies and the Alberta government, is irritated by eastern proposals to equalize gas costs across Canada and to restrict LPG exports. And it is concerned that government attempts to help eastern producers will be viewed by other countries as an illegal subsidy, subject to countervailing duties. This could hurt western chemical companies, which are heavily export oriented.

The eight eastern companies discount this argument, but it can't be brushed aside. The federal government also is concerned about creating another potential Canada-U.S. trade problem.

East-West feuds are nothing new in Canada, so it is not surprising that the West doesn't want to see federal funds go to support jobs in the East that eventually could end up in Alberta.

All of this leaves Ottawa between a rock and a hard place; in fact between several rocks and several hard places. It faces another East-West confrontation, an oil-vs.-natural gas battle, and it is caught between a desire to save jobs and a shortage of money to do much about it.

No doubt the task force report painted a bleak picture of the outlook for eastern petrochemicals. But Ottawa watchers believe that, unless the ministers involved change their present line of thinking, no large-scale bailout is likely.

They see little hope that the government will suspend the up-front taxes on oil for petrochemicals. Other industries would scream for similar treatment. It also would irritate Alberta and reverse NEP policy of encouraging gas substitution for oil.

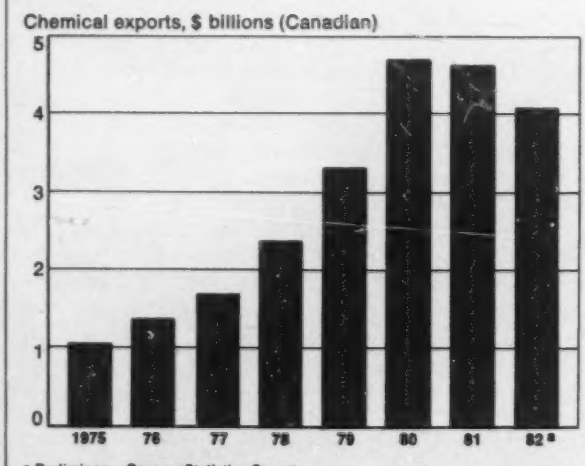
Best guesses are that Ottawa will provide some special assistance for Petromont, if only because politically powerful Quebec is forcing the issue. The jury is still out on what Petrosar may get.

Whatever does come out of Ottawa will be a political decision as much as a business decision. That decision, tough as it is, could come very soon.

Says one Canadian chemical expert, "It would help if the industry closed ranks with one point of view. The real competition lies beyond the Canadian borders."

But that closing of ranks is unlikely to happen. □

Exports of Canadian chemicals slipped in 1982



a Preliminary. Source: Statistics Canada

Flame Retardants in Plastics: Growth Depends on Regulation

While they wait for the government to act, producers of flame retardants focus on high-technology uses and better performance

David Webber, C&EN New York

The federal government has been wielding regulation like a rod of discipline over the chemical industry for so many years now, most chemical producers find it difficult to think of agency action toward them as anything but a scourge. But to the producers of flame-retardant chemicals used in plastics, the government's big stick looks more like a magic wand.

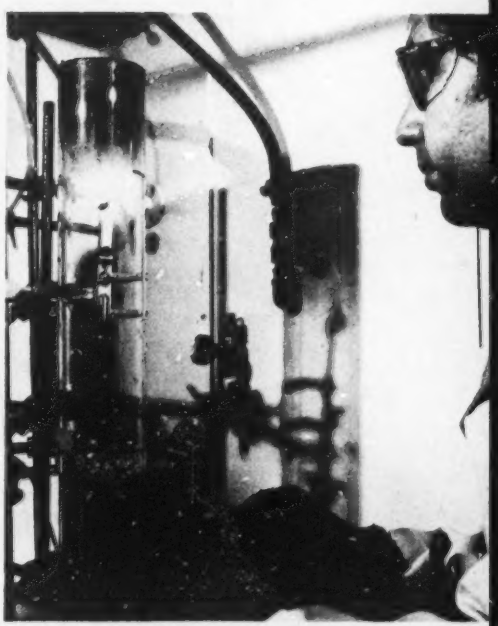
Stricter federal fire safety standards for materials used in construction and furniture could increase the market for many types of flame retardants hundreds of percentage points almost overnight. There is only one problem. The government has to wave that wand. And flame-retardant producers, made distrustful of the federal regulatory bodies by their history of sudden policy reversals and slow action on fire safety, fear it won't happen.

The shock of the string of notorious fires that have taken place in the past few years in the U.S. raised expectations in many people that the federal government finally would be pushed, as it often is by human catastrophe, into undertaking the task of creating new fire-safety standards. The main focus of the new strictures, citizens' groups demanded, should be plastic and urethane foam furnishings, because the fumes produced by the combustion of the many synthetic materials commonly used today frequently have been blamed—as yet without conclusive scientific proof—for causing more deaths than are caused by flames, heat, or the fumes emitted by natural materials.

For the most part, however, the new standards have not appeared. California, regularly a leader in consumer-oriented laws, has unilaterally imposed tougher flammability standards on furniture upholstered with flexible urethane foam. And the state of New York has appointed a special commission to study the scientifically labyrinthine problem of products of combustion toxicity. Elsewhere, on the state and local levels, committees have formed to deal with the same question, and everywhere consumer advocates have fulminated unceasingly against the perils they see in burning synthetic materials.

At the federal level, however, attempts to create laws or regulations on fire safety have fizzled like so many matches held up to wet wood. The Consumer Product Safety Commission, for instance, which many expected to regulate the flexible foam furniture industry, has agreed instead to allow the Upholstered Furniture Action Council, a body representing seven furniture trade associations, to carry out a protracted program of testing and research aimed at developing voluntary industry standards for fire safety. That policy is in line with the Reagan Administration's broad movement away from government regulation. But consumer advocates complain that the Action Council's program, which still seems a long way from fruition, has been marked more by inaction than anything else.

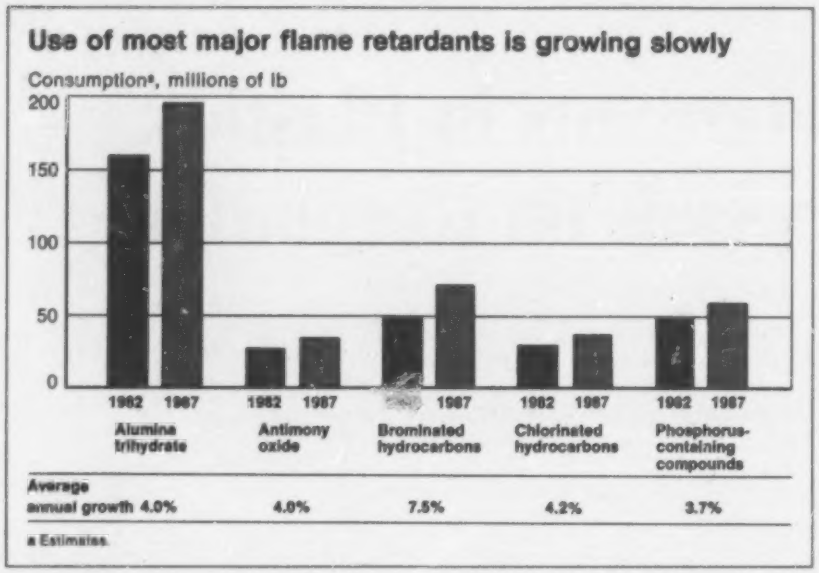
"With the current regulatory climate, we don't foresee national regulations that would result in a big boon for us," comments Harold James, market manager for flexible urethane at Olin Corp., which produces a chlorinated phosphate flame-retardant additive for flexible foam.



An experimental flame retardant for plastics is tested by PPG Industries research chemist Ash Jagtap

Nor do most other flame-retardant chemical producers. Instead, they must market their chemicals on the basis of their potential customers' self-interest. The addition of flame-retardant chemicals to compounded plastic and foam products where it is not required, the sales pitch goes, can reduce exposure to product liability, and consequently enhance the image—and value—of the customer's product.

"One thing that's helping keep the fire safety of materials in the limelight is insurance costs," remarks Charles T. Ludwig, director of marketing of flame retardants at Great



Lakes Chemical, the leading producer of brominated flame-retardant chemicals. "People like Factory Mutual are getting in and saying, 'Hey, we've got a real responsibility, and even though it may not be legislated, if you do this and this and this, it will help to reduce your insurance cost.' "

In addition, since government standards are probably inevitable, the voluntary adoption of high levels of flame retardancy by manufacturers now may spare them from the kind of best-available-technology standards that plague the chemical industry's pollution control efforts. Although the approach and motives of all parties involved are somewhat different, both flame-retardant chemical producers and manufacturers of products that use synthetic materials are promoting a performance approach to fire safety. They hope that by coming up with systems—combinations of flame-retardant chemicals and structural modifications—for products like furniture that are substantially harder to ignite and, if burning, give off less smoke, they will keep the federal wolf out of the fold.

At the same time, however, flame-retardant chemical producers often are stymied by factors that convince many plastics compounders to wait until the government forces them to raise the fire safety of their products. Flame-retardant chemicals cost money, an obvious fact that discourages managers trying to improve profitability as industry begins its recovery from recession. Why add chemicals that cost an average $1.50 per lb, many production managers ask, when the only immediate commercial value will be to enhance the product's image, a financially unquantifiable achievement.

But even more crushing to many a flame-retardant chemical salesman's argument is the technical objection: The majority of these compounds are additives that do not join in the molecular structure of the plastic being treated. As a result, all resins mixed with flame-retardant additives sacrifice something in the way of performance or appearance or both. Often, as well, there are problems with processing and damage to plant equipment. Finally, the greater propensity of additive rather than reactive chemicals to leach out of the substrate complicates questions of toxicity.

These problems and the fact that the two biggest markets for flame-retardant chemicals—polyvinyl chloride (PVC) and polyurethanes—depend ultimately on the recession-sensitive automobile and housing industries combined to reduce sales last year and to produce predictions for many flame-retardant chemicals of growth at only the rate of the gross national product over the next five years. The only remarkable recent growth has come, and probably will continue to come, in the high-technology electrical/electronics sector, dominated by printed circuit boards, business machines, other electric appliances, and wire and cable applications. This shift in the market favors the flame-retardant chemicals that treat thermosets such as epoxy resins, and engineering thermoplastics such as high-impact polystyrene and polyphenylene oxide.

Consequently, bromine compounds have become the most vital part of the flame-retardants business in recent years. The major flame-retardant chemical for epoxy resins, for instance, is tetrabromobisphenol-A (TBBPA), used extensively in printed circuit boards. The only U.S. producers have been Great Lakes Chemical and Dow Chemical. But Ethyl Corp.'s Saytech subsidiary, whose announced goal is to wrest the lead from Great Lakes, is building a 15 million lb-per-year TBBPA plant in Magnolia, Ark., scheduled to come on stream next January. Saytech also has intensified competition in the market for decabromodiphenyl oxide (decabrom), used primarily in high-impact polystyrene (most of which goes into television set bodies), by bringing on a new unit last December in Magnolia that will have an ultimate nameplate capacity of 10 million lb per year. The facility has greater flexibility than Saytech's previous decabrom plant in Sayreville, N.J., which now will be diverted into other product lines. The other producers of decabrom are Great Lakes and White Chemical. The market for flame-retardant treatment of acrylonitrile-butadiene-styrene (ABS) is overwhelmingly dominated by Great Lakes with its octabromodiphenyl oxide and other products.

Producers of brominated flame retardants foresee overall average annual growth for their products of about 7.5% over the next five years. Those products used in epoxy, says James D. Innes, vice president of marketing and sales at Saytech, are mostly TBBPA and will grow 8 to 9% per year. Sales of decabrom, he predicts, will increase at an average annual rate of 7 to 9% between 1982 and 1987.

But high-impact polystyrene and ABS, big users of bromine com-

pounds, do not own the increasingly important business machine and appliance sector. Modified polyphenylene oxide (PPO), which challenges in many areas, is flame-retardant-treated with nonhalogenated phosphate esters. Use of modified PPO, produced by General Electric, Borg Warner, and others, recently has been spurred, some sources say, by pressure applied by GE. GE makes a broad range of high-technology products used in the business machines sector.

Still, for producers of nonhalogenated phosphate ester flame retardants, sales to makers of modified PPO have been no more than a small bright spot. About 75% of these flame-retardant chemicals go into flexible PVC, which was hurt by last year's sharp decline in construction. Even though housing starts are rising now, nonhalogenated flame-retardant chemical producers worry that fears of smoke and toxic fumes from PVC furnishings will dampen the market for flexible PVC in coming years, taking the edge off the economic recovery. The market is described as essentially mature; anticipated five-year growth likely will average no more than 3 to 4%.

"Competing products are more economical," says one producer resignedly. "Customers only use phosphate esters when they have to, when they can't find a substitute."

Nor have recent years been kind to halogenated phosphorus-based flame retardants, the great majority of which are used in urethane foams. Not only did the recession in housing construction hurt sales, but the continued lack of fire safety regulations have their greatest impact in this market. The only standard on flexible polyurethane foam furniture on the books today is California's Bulletin 117. (Automobile seat cushions are controlled by the Department of Transportation's Motor Vehicle Safety Standards, and other agencies regulate foam flammability performance in other smaller business sectors.)

As a result, not only is business expected to grow no more quickly than GNP, lack of optimism has sapped producers' enthusiasm for the development of new products and aggressive marketing. "We don't have a whole lot of faith in future regulations," comments Olin's James, "so we're no great shakes in R&D. We're not planning anything new now."

As James explains it, foam producers who are not required by law to use flame retardants have no incentive to do so. The only exception is combustion modified, high-resilience foam used in high-risk applications sold on the basis of protection from product liability.

"At this point," James says, "most of us are dead in the water."

More movement will be apparent in the market for high-performance chlorinated hydrocarbon flame retardants, which is dominated in the U.S. by Occidental Chemical. Use of Occidental's Dechlorane line of additives, says manager of performance chemicals Earl H. Levith, will grow at an average rate of 7 to 9% over the next five years. On the other hand, he concedes, the company's HET chlorendic acid, a reactive flame-retardant chemical, probably will grow at no better than a 2% annual rate for the next two to three years, rising to the pace of GNP after that. HET probably accounts for somewhat more than half of Occidental's flame-retardant chemical sales in poundage.

Almost all HET produced goes into unsaturated polyester resins, a sector that has been severely battered by the recession because of its reliance on transportation and marine recreation applications. According to Society of the Plastics Industry statistics, U.S. consumption of flame-retardant polyester resins plunged 26.5% over the first 11 months of 1982 compared to the same period the year before.

That is why Occidental is aggressively focusing its attentions on Dechlorane. The major markets for Dechlorane are cross-linked polyethylene and ethylene-propylene rubbers for wire and cable applications, polypropylene, nylon 6 and 6/6, and some epoxies and adhesives. Overseas, Dechlorane is used in polybutylene terephthalate, a market Occidental would like to break into in the U.S.

But Occidental will encounter brominated flame-retardant chemicals in a number of applications treated with halogens.

"Dechlorane is pretty mature," remarks Levith, "so we are going after new segments of the market. We're spending a lot of money on R&D for Dechlorane. We're very aggressive as far as working with customers goes, finding new products for them."

Polyvinyl chloride, urethanes dominate flame-retardant chemical use in plastics

Millions of lb of flame retardants[a]	ABS	Epoxy	Unsaturated polyester	Polyolefins	Polystyrene	PVC	Polyurethanes	Others	Total
Antimony oxide	2.6	1.3	1.3	3.3	4.3	15.9	—	4.3	33.0
Brominated hydrocarbons	9.5	18.5	b	b	18.5	—	b	—	50.0
Chlorinated hydrocarbons	—	—	7.0[c]	b	—	21.0[d]	—	b,e	34.0
Boron compounds	—	—	b	—	—	b	—	b	7.0
Phosphorus-containing compounds									
Halogenated	—	—	b	—	b	—	18.0	b	23.0
Nonhalogenated	—	—	b	—	—	24.5	—	b	32.6
SUBTOTAL	**12.1**	**19.8**	**>8.3**	**>3.3**	**>22.8**	**>61.4**	**>18.0**	**>4.3**	**179.0[f]**
Alumina trihydrate	—	11.0	68.4	b	—	b	—	54.0[g]	180.0
GRAND TOTAL	**12.1**	**30.8**	**>76.7**	**>3.3**	**>22.8**	**>61.4**	**>18.0**	**>58.3**	**359.6[f]**

a Estimates for 1981. b Small application; data not available. c Mostly chlorendic acid. d Mostly chlorinated paraffins. e Mostly Occidental Chemical's Dechlorane. f Excludes polyols, molybdenum, zinc, and metal oxides. g For latexes used in carpet backing.

Reformulation in the quest for new flame-retardant products is the reigning dynamic in the antimony oxide industry as well. Sales of antimony oxide, which is used as a synergist with other flame-retardant chemicals except in inherently flame-retardant PVC, fell more than 20% last year. Although the recovery this year may bring a substantial rebound, growth over the long run is not expected to be any better than that of GNP.

"We're looking at existing halogenated flame-retardant additives and trying them in combination with antimony oxide in many resins," explains F. Joseph Prior, manager of product marketing for PPG Industries, the largest U.S. producer of antimony oxide. "Our thrust is to try to reduce the amount of additive required."

The antimony oxide industry has its problems. There is overcapacity in the U.S., but, despite the forecasts of a few years ago, no producer has gotten out of the business. Even more debilitating are imports, which enter the U.S. in great quantity and at low prices, forcing down the prices of domestic producers. Although companies admit this has helped them win some business away from competing materials on the basis of cost, it has hardly increased profits.

And producers also imply that opportunities in flame-retardant chemicals, even with reformulations, may be limited. "The flame-retardant area is maturing," Prior says. "There have been no new flame-retardant molecules in the past few years."

Antimony oxide makers have shifted at least part of their energies as a result to smoke suppression, an aspect of fire protection that many flame-retardant chemical producers believe is most likely to be addressed by regulators first.

"Our attention now is on smoke suppressants rather than on flame retardants," notes Ted Halchak, marketing manager for flame retardants and urethane catalysts at M&T Chemicals. "This is important especially in PVC and related applications."

Halchak says that M&T has been working on both synergist and additive smoke suppressants for a year now. At PPG, research has been under way for more than a year on smoke suppressants made from both antimony oxide and other materials. According to PPG's Prior, the company has found chemicals that reduce smoke generation 50%.

Work on smoke suppressants, in fact, is widespread in the flame-retardants industry. Occidental, for instance, reports Levith, expects regulations on smoke control, and has launched what he calls an "aggressive" program to develop products. "We're going to be in the forefront in smoke technology."

But other flame-retardant chemical makers warn that cashing in on the growing smoke-control market will not be easy. "We've looked at the commercial materials, and we haven't found a smoke suppressant that really works," says Great Lakes' Ludwig. "The problem is that when you load materials up heavily enough to try to reduce the smoke, you have a significant decay in properties that are important to the molded part."

Other flame-retardant segments are making similar attempts to reformulate their products to find new markets or strengthen their hold on old ones. Alumina trihydrate, for instance, which is the biggest volume flame retardant (it is, however, far less expensive than most other flame-retardant chemicals), finds the bulk of its flame-retardant uses in unsaturated polyester resins for molded bathroom fixtures and rubber latexes for carpet backing. Growth in these sectors is essentially that of GNP.

Solem Industries, however, produces a line of surface-treated alumina trihydrate, processed with a variety of silanes, stearates, titanates, and other agents. These new formulations give alumina trihydrate uses it did not have before in urethane foam, wire and cable coatings, carpet tile, and polyolefin injection-molded parts and sheets. Although surface-coated grades now account for a small share of the alumina trihydrate market, they ultimately could boost growth tremendously.

Solem's R&D coup is an achievement that other producers would love to match. In particular, companies would like to come up with more polymeric flame-retardant systems, because they do not have the performance and toxicity disadvantages of the additive chemicals. But because of fear that beneficial regulations will not appear soon enough, reluctance to assume the premarketing notification expenses entailed by the Toxic Substances Control Act (TSCA), or, in some cases, pessimism over the chances of expanding existing markets, many companies are carrying out research on limited budgets.

Technician at Witco Chemical's Pearsall chemical division exposes polyolefin fabric sample treated with new flame retardant to flame from gas torch in screening test

"Since TSCA, it's become very difficult and expensive to offer new products to the market," says Great Lakes' Ludwig, whose company is one of the more active introducers of new flame-retardant chemicals. "Therefore, you spend time in really improving what you've got or become a master of blendology. You tend to mix or combine materials to get certain advantages of each. You need to make sure the ball goes way over the fence, that it's a clear home run before you pump the dollars into developing it."

"TSCA is not a major problem," remarks Saytech's Innes. "It becomes a cost, but it does not hamper the movement toward new products. If the market is there, it will support the cost of the toxicity work." □